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(54) Steel cable conveyor belt with improved penetration and rip resistance

(57) A steel cable conveyor belt (5) with improved penetration and rip resistance is made by plying up a series of rubberized longitudinal steel cables (6) to give a core, placing a ply of rubberized woven fabric such as polyaramide or nylon over the core. A ply of rubberized closely spaced, essentially in contact wire, such as a ply for earthmover tires, cut to cover the core in transverse direction, is positioned perpendicular over the longitudinal steel cables (6). A cover stock ply (7) is applied over the layer (10) of transversely positioned cables (9). The underside of the core has rubberized woven fabric (12) positioned there beneath and a rubberized pulley ply (13) beneath the woven fabric ply (12). The plied up belt (5) is cured with pressure and heat to adhere the plies together and cure the rubber.

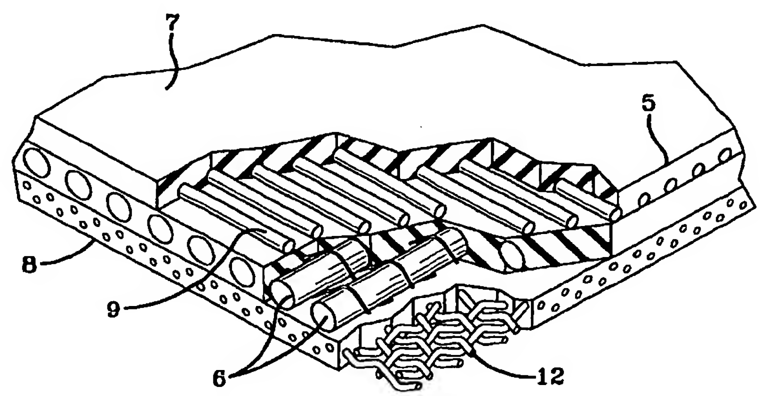

FIG-1

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Description

1. Technical Field

This invention relates to an improvement in steel or wire cable conveyor belts to offer greater resistance to penetration by rocks, shale, tramp metal or other unknown objects which drop on the belt during service. More particularly, this invention relates to a method and its product to improve the resistance to ripping of a steel or wire cable conveyor belt should an object penetrate through the belt, remain lodged in the belt and then become stuck against some unknown fixed object such as a conveyor or idler frame.

2. The process of this invention calls for the use of a layer or layers of closely packed transversely positioned steel cable positioned above a core comprising longitudinal cable or wire of the rubberized belt. Thus, the belt of this invention comprises a rubberized series of longitudinal steel cables having a series of rubberized transversely packed steel cables essentially in contact positioned on top of the rubberized longitudinal cable or wire member which is the load carrying cables of the belt with a cover ply or plies on top of the belt and a pulley ply or plies on the bottom of the core of the belt. In this process a ply or plies of closely spaced steel cables are applied above the plane of the belt carrying longitudinal cables but perpendicular to the direction of those load carrying cables so as to not adversely impact the troughability of the belt. A second ply of closely spaced steel cables or ply of fabric below the plane of the belt's load carrying longitudinal cables may be provided to afford resistance to transverse movement of the load carrying cables or members from the impact loads on the top cover of the belt. Of course, the size, strength and density of the steel cables in the ply or plies and the type of fabric utilized are to be selected to provide the degree of strength and improvement in penetration and rip resistance required by the severity of the application such as a belt for conveying tar sands or lumps of coal.

3. Background Art

Steel cables or a ply of fabric above or below the load carrying wire or cable of the conveyor belt to provide improved resistance to cutting and gouging of the covers from rock, shale, coal or tramp metal and to improve the rip resistance of such belts are on the market. However, these commercial belts do not provide a high degree of resistance to penetration by such objects. When the object penetrates the belt, these belts exhibit inferior abuse resistance and tend to tear apart longitudinally. Also, relative to their cost, the life of these belts is materially effected by their poor resistance to penetration and tear.

4. Summary of the Invention

This invention provides significant improvements in steel wire or cable belts by using transversely located series of steel cables, preferably essentially in contact, located above the load carrying longitudinal steel wire or cable to provide resistance to transverse movement of the load carrying cables and afford satisfactory troughability. Of course, these perpendicularly located or positioned steel cables are preferably separated at least by an insulating or adhesive rubber layer or coating to bind the two together. Also, a breaker stock may be used to absorb the load impact on these perpendicular layers of steel wire or cable. The breaker strips may be placed above and below the core of the belt which generally comprises a series of rubberized longitudinal parallel steel cables with rubberized, insulation layers on each side. There is on top and bottom of each belt respectively a top cover member and a pulley member.

5. The rubber used in these belts are any of those generally used in belts or tires but each of the belt has those rubbers that are preferred for its uses. For examples, acrylonitrile/butadiene rubber is often used for the belts to carry tar sands and related materials, while natural rubber and/or butadiene/styrene based compound rubbers may be used for sand or coal and like handling.

6. The nature of this invention may be more readily seen and understood by reference to the drawings where:

FIG. 1 is a partial perspective view of a piece of belt showing the belt along a cut end such as where a joint must be made.
FIG. 2 is a cross-sectional vertical view along the end of a belt.
FIG. 3 is a vertical side view of the belt.

7. Referring to the drawings, numeral 5 designates the belt, and in FIG. 3 the longitudinal steel cable 6 is shown with a load cover stock 7 above and a pulley stock 8 below the longitudinal cable 6. The number 9 designates the individual steel cable of the transverse or perpendicular positioned steel cable layer 10 placed above the layer of longitudinal steel cables 6. The longitudinal steel cables 6 are covered or embedded in a rubber compound 15 sufficient to absorb the shock of the material being handled and reduce contact between the wires. The transverse

cable layer 10 is likewise surrounded by a rubber coating. The load cover stock 7 is positioned above the transverse cable layer 10 as shown in the drawings.

8. Beneath th longitudinal cables 6 is located pr ferably at least one layer of a rubberized fabric or breaker 12. The rubberized fabric consists of cords which may be parallel to each other in one layer. In an alternate embodiment the cords are wov n. A pulley layer or cover 14 of elastomeric material is applied as normally used in belts.

9. It has been found that the use of weft cords 16, such as the fine steel monofilaments or threads extended around the individual steel cables 6 as shown in Figure 2, not only facilitates the handling, rubberizing and placing the steel cable plies relative to each other but also offers resistance to penetration and tear of the belt. In an alternate embodiment, the weft cords 16 may be of fabric.

10. The fabric or breaker layer 12 beneath the longitudinal steel cables 6 with the use of the perpendicular layer of transverse steel cables 9 permits the belt 5 to more readily trough but also affords bounce that gives the belt improved bounce reaction to impact loads, which appears to reduce the overall penetration of the stray loads.

11. The transversely positioned steel cables 9 may be surrounded with a series of alternating twisted fabric cords extending around each wire to the next wire (not shown in the drawings).

12. In a still further embodiment, a rubberized fabric stock may be located between the topside of the longitudinal steel cables 6 and the perpendicular layer 10 of transverse steel cables 9 (embodiment not shown in the drawings). Such rubberized fabric stock may be woven fabric or fabric fibers, embedded in a rubber matrix. The fabric is preferably polyaramide or nylon.

13. It is understood that the expression "cables", used herein in connection with the references 6 and 9, means not only single metallic monofilaments as shown in the drawings but also at least two metallic monofilaments twisted together into yarns or cords. The metal is preferably steel.

14. Penetration Tests
The penetration tests were conducted using a tungsten carbide steel blade sharpened to an angle of 60° fitted to the underside the 31.8 Kg weight. The blade/weight was dropped onto the belt from 4.11 meters, resulting in 1150 joules. The belt was held in a frame at a 45° angle with respect to the line of travel of the blade and positioned such that the blade struck the belt section between adjacent belt tension cables.

15. Test Ratings
The rating system for the penetration test is based on the average of the sum of the length of cuts on the top cover and pulley covers, $(C1 + C2) / 2$) expressed in millimeters to give a penetration value.

16. Rip Tests
The rip tests were conducted using a hydraulic test bed fitted with a strain transducer.

17. One end of the belt was held in position using a specially designed jig while the force ram pulled a 7 mm wide by 25 mm long blade through the belt. The blade was held upright and rigid in a yoke fixed to the force ram.

18. The rating system for the rip resistance is the maximum force recorded during the 90-110 seconds of pull. One lbs equals 4,45 N.

19. Dividing the maximum rip force by the penetration value provides an ABUSE index. The higher the abuse index, the better the belt is.

20. Experimental Belt Descriptions
A number of experimental belts were made and tested by penetration test and rip test given herein. Also, the belts of this invention were compared with the commercial belts.

21. A number of experimental belts were made using ST3300 steel cable covered with 12 mm x 10 mm covers of acrylonitrile/butadiene rubber based cover stock as the core. This core was modified as indicated in Table I for the different experimental belts. The core was modified by plying up to place, between the rubberized longitudinal steel cable and the covers, a ply as listed above and below the longitudinal steel cables and the pulley cover as listed below from AA to AD.

22. The experimental belts evaluated were based on a ST3300 steel cable conveyor belt with 12 mm X 10 mm covers of NBR based cover stocks.

BELT AA	1 ply NR12000 fabric above longitudinal cables
	1 ply NR12000 fabric below cables
BELT AB	1 ply NR10000 fabric above cables
	1 ply NR10000 fabric below cables
BELT AC	1 ply HD30 steel cords above cables
	1 ply NR12000 fabric below cables
BELT AD	1 ply HR30 steel cords above cables; and only pulley cover belts

NBR is an acrylonitrile butadiene rubber, HR 1200 and 1000 are rubber coated woven fabric and HD30 is a rubberized steel wire tire ply cut to cover the belt's core.

23.

Table I

BELT ID	LENGTH OF CUTS			RIP FORCE	ABUSE
	Top C1	Pulley C3	Ave	Lbs	Factor
Belt AA-1	114.2	43.4	78.8	10920	
Belt AA-2	123.2	42.9	83.6	8500	
			(81.2)	(9710)	119
Belt AB-1	123.9	45.4	84.6	8150	
Belt AB-2	117.2	43.0	80.1	7360	
Belt AB-3	124.2	47.8	86.0		
			(83.6)	(7755)	92
Belt AC-1	59.7	0.0	29.9	10830	
Belt AC-2	58.5	0.0	29.3	9870	
			(29.5)	(10350)	351
Belt AD-1	79.6	0.0	39.8	10270	
Belt AD-2	62.2	0.0	31.1	12740	
			(35.4)	(11505)	325

24. Comparative tests results on commercial conveyor belts are shown below in Table II.

25.

Table II

BELT ID	LENGTH OF CUTS			RIP FORCE	ABUSE
	Top C1	Pulley C2	Ave	Lbs	Factor
ST5000	182.9	144.5	163.7	7250	44
(No breakers)					
ST2000	181.4	104.3	142.9	9400	65
(2 Leno breakers in top cover)					
ST3300	124.0	56.1	90.1	12130	134
(HS nylon top and pulley)					
Goodyear A	68.4	0.0	34.2	8670	255
(1 Ply large diameter steel cords in top cover)					
Goodyear B	88.8	0.0	44.4	5180	116
(1 Ply small diameter steel cords in top cover)					

26. The belts of Tables I and II were tested by penetration and rip tests. Table II is test value on commercial belts which shows the inferior penetration and abuse factor of the prior art belts relative to invention belts AC and AD of this invention.

27. While certain representative embodiments and details have been shown for the purpose of illustrating the invention, it will be apparent to those skilled in this art that various changes and modifications may be made therein without departing from the scope of the claims.

Claims

1. A cured conveyor belt (5) that exhibits superior resistance to penetration and tear testing characterized by a core member having a series of rubberized parallel longitudinal metallic cables (6), covered on each side with a rubber layer (15), on its top side at least one layer (10) of a rubberized closely spaced series of transversely positioned metallic cables (9) adhered to the core member, a rubberized fabric layer (12) adhered below the core member, an upper cover (7) suitable for carrying a load and a pulley cover layer (14) beneath said fabric layer (12).

2. The belt (5) of claim 1 characterized in that the transversely positioned metallic cables (9) are connected by a series of alternating twisted fabric cords extending around each wire to the next wire.

3. The belt (5) of claim 2 characterized in that the fabric cords include polyaramide.

4. The belt (5) of claim 1 characterized in that the longitudinal metallic cables (6) are connected with metallic weft monofilaments or cords (16).

5. The belt (5) of claim 1 characterized in that the longitudinal metallic cables (6) are connected with fabric weft cords (16).

6. The belt (5) of any of claims 1 to 5 characterized in that the rubberized fabric layer (12) includes woven polyaramide fabric.

7. The belt (5) of any of claims 1 to 6 characterized in that the metall is steel.

8. A method of making a conveyor belt (5) as defined in any of claims 1-7 characterized in plying up the different layers and curing them at a pressure of 200 to 500 psi (1,38 to 3,45 MPa) from 30 to 90 minutes.

9. The method of claim 8 characterized in that the transverse layer(s) (10) is\are of steel cables (9) and are made by cutting a rubberized steel wire heavy duty earthmover tire stock to the width of said belt and placing said cut earthmover tire stock on said core member to run perpendicular to the longitudinal cables (6) of the core.

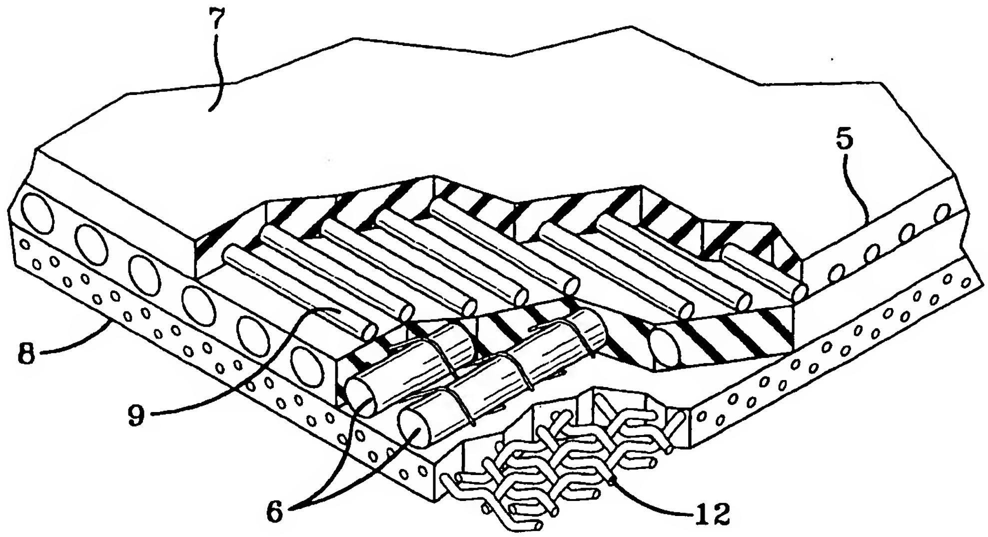

FIG-1

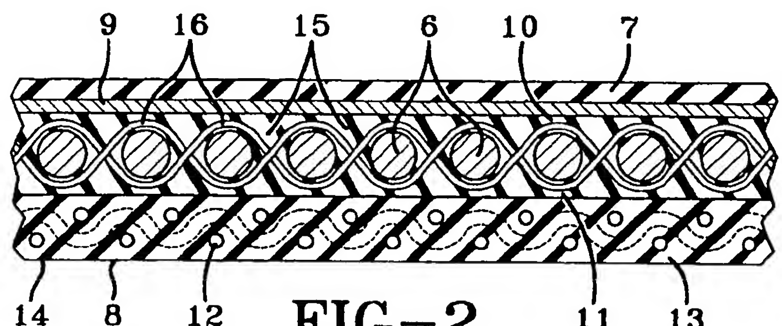

FIG-2

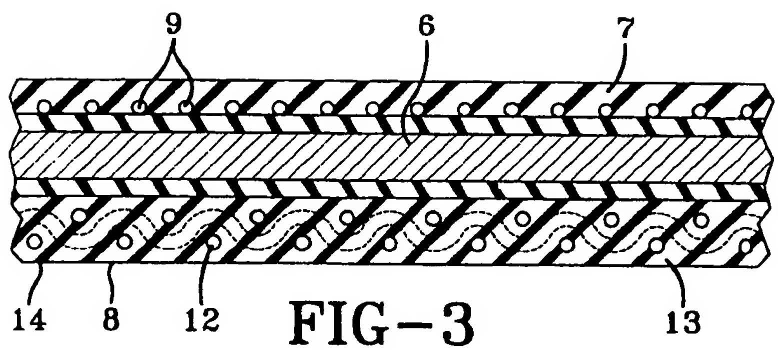

FIG-3

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EUROPEAN SEARCH REPORT

Application Number
EP 96 11 0857

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	GB-A-1 240 123 (BTR INDUSTRIES COMPANY) * the whole document * ---	1,2,7	B65G15/36
A	DE-A-25 57 025 (CONTINENTAL GUMMI-WERKE) * the whole document * ---	1,3,6,7	
A	US-A-3 973 670 (SPAAR) * column 2, line 3 - column 3, line 29; figures 1-3 * ---	1,2	
A	DE-A-25 32 190 (PHOENIX GUMMIWERKE) * claim 1; figure 1 * ---	1	
A	DE-U-18 77 972 (KLEBER COLOMBES) * the whole document * ---	1,4	
A	DE-A-25 20 943 (CONTINENTAL GUMMI-WERKE) * the whole document * -----	1	

TECHNICAL FIELDS SEARCHED (Int.Cl.6)
B65G

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	31 October 1996	Simon, J

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
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